

72-14

Announcement of Highway Safety Literature ... A Bi-Monthly Abstract Journal

HSL No. 72-14 July 21, 1972 HS-011 212 - 280; HS-800 626; 644 - 646; 648; 653 - 654; 657; HS-810 198; 200; HS-820 185



**HSL No. 72-14
July 21, 1972**



THIS ISSUE CONTAINS:

HS-011 211 - 280
HS-800 626; 644 - 646;
648; 653 - 654 & 657
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U.S. Department of Transportation / National Highway Traffic Safety Administration

HIGHWAY SAFETY LITERATURE

... A Bi-Monthly Abstract Journal

Published twice-a-month by the National Highway Traffic Safety Administration,
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INTRODUCTION

Publications such as journal articles, proceedings, and research reports announced in *Highway Safety Literature* include some of the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 72 designates the year and 1, 2, 3, etc. the individual issues. To aid the user in locating citations by the HS-number, the cover bears the inclusive entry number for each issue.

Entries in *HSL* are arranged according to the NHTSA Subject Category List shown in the Table of Contents. The list is a two-level arrangement consisting of five major subject fields subdivided into 59 subject groups. Documents related directly to

the National Highway Traffic Safety Administration (NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series), NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration. HS-800 000 series and HS-820 000 series are available for purchase from NTIS or GPO (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval.

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

SAMPLE ENTRIES

Subject Category Array	
NHSB Accession no	HS-800 218 Fld. 5/21; 5/9
Title of document	AN INVESTIGATION OF USED CAR SAFETY STANDARDS--SAFETY INDEX: FINAL REPORT. VOL. 6 - APPENDICES G-L
Personal author(s)	by E. N. Wells; J. P. Fitzmaurice; C. E. Guilliams; S. R. Kalin; P. D. Williams
Corporate author	Operations Research, Inc.
Collation	
Publication date	1969 150p Contract FH-11-6921 Report no. ORI-TR-553-Vol-6; PB-190 523
Abstract	Appendices G-L to this study of used car safety standards include: indenture model diagrams for classes I-IV motor trucks; degradation, wear, and failure data for motor truck classes I-IV; and safety index tables for classes I-IV motor trucks. Search terms; Wear; Trucks; Failures; Used cars; Inspection standards

AVAILABILITY: NTIS

HS-004 497 Fld. 5/19

AUTO THEFT--THE PROBLEM AND THE CHALLENGE

by Thomas A. Williams, Sr.

Journal citation Published in *FBI Law Enforcement Bulletin* v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the auto theft problem and comments on anti-theft devices available now or in the planning stage.

Search terms: Theft; Theft protection; Stolen cars

(Note: If the date of a report or Journal article is not given, the small letters nd will appear)

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NOTE: Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community. While brand names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval of any particular product, course, or equipment by the U.S. Department of Transportation, National Highway Traffic Safety Administration.

Harry A. Feinberg
Managing Editor

AVAILABILITY OF DOCUMENTS AND INSTRUCTIONS FOR ORDERING

Articles and reports whose citations and abstracts appear in HSL are acquired from many sources, such as periodicals, journals, NHTSA Contractors' reports and NHTSA staff speeches, and other reports. Those reports other than NHTSA Contractors' reports and NHTSA generated reports and speeches (see introduction) are assigned a lower consecutive accession (HS-) number.

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NHTSA Contractors' reports and other reports can usually be obtained as indicated under AVAILABILITY. However, there is no certainty that copies will be available for more than a limited period after a report is issued.

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GPO: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Give corporate author, title, personal author, and report number. Prepayment is required by GPO coupon (NTIS coupons are not acceptable), check or money order (made payable to the Superintendent of Documents).

HRB: Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

NHTSA: National Highway Traffic Safety Administration, General Services Division, Washington, D.C. 20591 (Telephone (202) 426-0874), Give HS-No.

SAE: Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report numbers. Prices given are list; discounts are available to SAE members and sometimes to libraries and U.S. Government Agencies. Prepayment is required; orders received without payment are subject to a \$1 handling charge.

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WHEN REQUESTING a document, to be absolutely sure you receive what you order, give the accession number (HS, PB, AD number) or report number (in cases such as an SAE document), title of report, and the personal or corporate author (whichever is cited). When requesting an HS-numbered document from NTIS, add DOT/to the prefix HS-; example HS-800 000 should be ordered as DOT/HS-800 000.

1/0 ACCIDENTS

1/2 Injuries

HS-011 212 Fld. 1/2; 1/3

SOCIAL, PSYCHOLOGICAL, AND EDUCATIONAL CHARACTERISTICS OF ADOLESCENTS AND YOUNG ADULTS KILLED IN INDIANA AUTOMOBILE ACCIDENTS

by William Asher; Beverly Dodson

Purdue Univ., Joint Hwy. Res. Proj.

1970 22p 9refs
Report no. JHRP-26

From the literature it is apparent that the prime contributor to automobile accidents is the human factor. Furthermore, teenagers and adults in the first half of the twenties have one-third of all accidents but constitute only 21% of all drivers. This longitudinal study of automobile accident fatalities in this age group determined with some accuracy that those killed are lower in educational and socioeconomic levels than their cohorts. Also, they may have distinct psychological differences. Driver education is of no predictive importance and, in fact, may be somewhat of a factor in increasing the death rate, since these drivers learned to drive at a younger age. Four hundred fifty-five social psychological, and educational variables were tested, and 95 showed differences between the fatality group and the norms. Of perhaps greater importance is the data collected, from which a far better study of this type could and should be done.

Search terms: Indiana; Driver characteristics; Adolescent drivers; Young adult drivers; Fatalities; Accident factors; Driver educational levels; Driver social class; Socio-economic data; Psychological factors; Accident studies

HS-011 213 Fld. 1/2; 5/14; 5/4

SOME COMMENTS ON THE PREVENTION OF INJURY AND DEATH AMONGST VEHICLE OCCUPANTS

by E. Grattan

Published in *Medico-Legal Journal* v39
p58-68 (Jan 1971)Presented at Royal Society of
Medicine meeting, 14 Jan 1971.

The relationship between the injury and the part of the auto interior impacted by the victim is described. Injuries can be prevented by safer auto design, energy absorbing interiors, and usage of seat belts. Aspects discussed include laminated glass and head injuries; steering columns and chest injuries; spinal fractures and roof failures. Questions from the audience dealt with air bags, drinking drivers, driver behavior, and accident prevention.

Search terms: Secondary collisions; Injury prevention; Injury severity; Energy absorbing systems; Interior design; Seat belt usage; Head injuries; Chest injuries; Spinal fractures; Laminated glass caused injuries; Steering wheel caused injuries; Roof caused injuries; Air bag restraint systems; Drinking drivers; Driver behavior; Accident prevention; Safety design; Automobile design; Fatality prevention

1/3 Investigation

HS-011 214 Fld. 1/3; 3/4

DETERMINING AFFECTIVE STATES INFLUENCING DECISION MAKING AND PSYCHOMOTOR SKILLS OF AUTOMOBILE DRIVERS

by Albert Zavala

Cornell Aeronautical Lab., Inc.

1971 21p 8refs

Presented at Symposium on Psychological Aspects of Driver Behavior, Noordwijkerhout, Netherlands, 2-6 Aug 1971.

In many auto accidents, events immediately prior to impact are critical predisposing factors. Knowing the nature of these events is important in establishing what skills are needed to handle emergencies. When an accident is fatal, it is often more difficult to learn what the pre-impact events were. A method for obtaining pre-impact information, known as the psychological autopsy, is described, together with the value of information derived from this method and implications involved in its use. Survivors found therapeutic value in the interviews, and it is sometimes possible to determine whether a case was accident or suicide. Some case histories are given, in most of which emotional stress was an important pre-crash factor.

Search terms: Accident investigation; Precrash phase; Driver emergency responses; Accident causes; Psychological factors; Autopsies; Interviews; Decision making; Motor skills; Driver performance under stress; Suicide by vehicle; Accident case reports; Emotions

HS-011 215 Fld. 1/3; 2/9

FREEWAY ACCIDENTS AND LEVELS OF SERVICE

Missouri State Hwy. Dept.

1971 15p
Report no. MCHRP-71-6

In cooperation with Federal Highway Administration.

The 1965 edition of the *Highway Capacity Manual* explains the characteristics of each level of service with regard to traffic density, headways, and speeds, but no consideration is given to accident

1/3 Investigation (Cont'd.)

HS-011 215 Cont'd.)

hazards or potentials related to levels of service. The purpose of this study is to measure the relationship of various levels of service to freeway accidents. It was important to determine if increases in density resulted in concurrent increases of accident potential; if rear end accidents increased as headway decreased; and if running off the road accidents increases as headway increased. An expressway section in St. Louis was used in the study to measure accident rates correlated to levels of service and types of accidents to levels of service. There is a definite relationship between type of accidents and accident rates to levels of service, but this relationship could not be established by statistical analysis.

Search terms: Accident rates; Traffic density; Headways; Speed patterns; Accident risks; Accident types; Rear end collisions; Ran off road accidents; Statistical analysis; Accident studies; Traffic characteristics; Vehicle mileage; Traffic data analysis; Variance analysis; Freeways; St. Louis

1/5 Statistical data

HS-011 216 Fld. 1/5

THE ESTIMATED DIRECT COSTS (1970) OF TRAFFIC ACCIDENTS ON INDIANA RURAL STATE HIGHWAYS

by S. S. Hejal; H. L. Michael

Purdue Univ., Joint Hwy. Res. Proj.

1970 38p 9refs
Report no. JHRP-20

A cost study was made, using the records of all accidents on rural state highways in Indiana which were reported for the years 1967 and 1968. The accidents were analyzed statistically and classified

into groups based on severity, exposure, and vehicle type. Some characteristics of the accidents were also analyzed. Estimates of the direct cost in 1970 dollars were developed as follows: a fatality cost \$18,605, a non-fatal injury \$4,280, a property damage only accident \$606, and the average for all types of accidents is \$2,433. Finally, the costs of unreported accidents were estimated at 15% of the total accident costs.

Search terms: Accident costs; Unreported accidents; Statistical analysis; Accident types; Accident analysis; Accident severity; Accident risks; Fatalities; Injury costs; Property damage accidents; Rural accidents; Indiana; Damage costs

HS-011 217 Fld. 1/5

OPERATIONAL EFFECTS OF AUTO-UTILITY TRAILER COMBINATIONS OF RURAL HIGHWAYS IN KENTUCKY

by Bruce S. Siria

Kentucky Dept. of Highways

1971 127p 23refs
Report no. RR-302

An analysis of accident records indicated that automobile-utility trailer combinations are involved in a disproportionately high number of traffic mishaps. Locations which have a history of accidents involving A-UT vehicles indicated that differential crosswinds and unanticipated driving maneuvers contribute to driver loss of control. A-UT combinations contributed to the fatigue loss in pavement life approximately 50% as much as single-unit, two-axle, six-tire trucks (per vehicle). In general, this vehicle type constituted approximately three percent of the total traffic stream. Analysis of speed distributions indicated an equiva-

lency factor for A-UT combinations equal to that for trucks for similar roadway types and topographical conditions. Computer programs used to analyze the data are included.

Search terms: Accident statistics; Loss of control caused accidents; Travel trailers; Rural accidents; Kentucky; Truck equivalency; Crosswind; Wind forces; Speed patterns; Accident location; Pavement wear; Pavement damage; Accident studies; Time of day; Day of week; Accident rates; Statistical analysis; Axle load measurements; Vehicle weight; Computer programs

HS-011 218 Fld. 1/5

NEW YORK STATE ACCIDENT FACTS, 1969. AN ILLUSTRATED ANALYSIS OF 1968 ACCIDENT RECORDS

New York (State) Dept. of Motor Vehicles

1969 44p

Accident statistics are included on accident and injury rates; vehicle mileage; fatalities; seriousness of injury; statistics by counties; age distribution of people killed and injured; type of collision; directional diagrams of accidents; characteristics of drivers involved in accidents; pedestrian accidents; time of day and day of week; light and weather conditions; traffic control; road characteristics; and motorcycle accidents.

Search terms: New York (State); Accident statistics; Accident rates; Injury rates; Vehicle mileage; Fatalities; Injury severity; Age factor in accidents; Accident types; Accident scale drawings; Driver characteristics; Pedestrian accidents; Time of day; Day of week; Light conditions; Weather; Traffic control; Highway characteristics; Motorcycle accidents; Driver age; Driver sex; Sex factor in accidents

HS-011 219 Fld. 1/5

ANALYSES OF U. S. ARMY ACCIDENT DATA

by Clifford P. Hahn

Human Resources Res. Organization;
American Institutes for Res.

1971 73p

Contract DAHC-19-70-C-0012

Report no. HumRRO-TR-71-14

Existing army accident data were analyzed to seek relationships useful in reducing the number and severity of accidents. Project activities, distributional results, regression analysis results, and results from a method for comparing accident involvement rates are described. Characteristics of the existing record system and the types of analyses that can be conducted are also discussed. It is concluded that the present system seems adequate for inventorying accidents but not for identifying human factors associated with on and off duty accident experiences, identifying material and equipment design and use characteristics associated with on duty accidents, or determining man-vehicle-equipment interactions and their influences on accident and injury incidents.

Search terms: Military personnel accidents; Accident statistics; Accident studies; Accident analysis; Regression analysis; Accident rates; Accident types; Human factors; Vehicle design; Man machine systems; Injury rates; Accident causes; Accident records; Driver vehicle interface; Military drivers; Accident risks

2/0 HIGHWAY SAFETY**2/4 Design and Construction**

HS-011 220 Fld. 2/4

HIGHWAY SAFETY PROBLEMS WHICH ARISE BECAUSE OF OPERATIONAL DEFICIENCIES

by Walter W. Mosher, Jr.

California Univ. Los Angeles

1967 44p

Design and control aspects of the nation's highway transportation system need improvement. A far-reaching highway safety program to eliminate these faults should be undertaken. Much of the required technology exists to solve many of the problems, but lack of public and governmental interest has prevented their solution. To overcome the general problem, it will be necessary to bring about changed attitudes. Specific examples in which deficiencies presently exist are: design of the area immediately adjacent to the road; design of freeway ingress and egress; uniform ramp design; traffic capacity; road alignment and poor sight distance; freeway access and movement of emergency vehicles; service, rest, and recreational facilities. Deficiencies in traffic control are also described.

Search terms: Highway design; Safety design; Highway transportation; Roadside hazards; Fixed objects; Community support; Highway safety programs; Freeways; Ramps; Traffic capacity; Highway design speed; Emergency vehicles; Traffic control; Highway characteristics; Highway engineering; Sight distances; Rest areas; Recreational facilities; Service needs; Exits; Access control; Alignment

HS-011 221 Fld. 2/4

STATE OF THE ART RELATED TO SAFETY CRITERIA FOR HIGHWAY CURVE DESIGN

by John C. Glennon

Texas A and M Univ. Texas Transp. Inst.

1969 100p 31refs

Report no. RR-134-4

Prepared in cooperation with Federal Highway Administration.

The purpose of this study was to evaluate the validity of design criteria for horizontal highway curves. The evaluation was specifically concerned with the design equation (centripetal), assumed levels of tire-pavement side friction capability, safe side friction factors, maximum degree of curvature, maximum super elevation, and design factors of safety. It is concluded that minimum curve design standards employed by most states do not provide an adequate safety factor; that the standard centripetal force equation is reasonably valid; that the "typical" relationship between tire-pavement friction and vehicle speed is not valid; that the use of locked-wheel skid trailers to measure pavement side friction is questionable; that the use of friction demand design values relating to driver discomfort has no objective safety factor; that vehicles will not necessarily follow the path of the highway curve exactly; that other variables may reduce the safety factor; that minimum curve design standards need upgrading.

Search terms: Road curves; Highway design regulations; Highway design; Safety design; Pavement skidding characteristics; Pavement skid resistance; Pavement surface texture; Highway standards; Design standards; Friction studies; Tire tests; Mathematical models; Tire pavement interface; Tire road contact forces; Tire side forces; Comfort; Cornering; Vehicle control; Coefficient of friction; Wet road conditions; Speed patterns; Highway design speed

2/9 Traffic Control

HS-011 222 Fld. 2/9

AVALANCHE-DIODE AND GUNN-EFFECT DEVICES FOR DOPPLER RADAR APPLICATIONS. FIRST ANNUAL REPORT

by G. I. Haddad; W. R. Curtice; C. Chao; J. T. Patterson

Michigan Univ.

2/9 Traffic Control (Cont'd.)**HS-011 222 (Cont'd.)**

1970 85p 9refs

The properties of avalanche-diode and Gunn-effect devices for use in doppler radar systems and in particular in the self-detection mode of operation have been evaluated. It has been shown that these devices can be employed in measuring the velocity of a moving object from extremely low to high speeds. The sensitivity in the self-detection mode is such that these devices can be employed in many highway safety applications such as traffic monitoring, collision avoidance, traffic control, and others. These devices will be employed extensively in highway safety applications in the future.

Search terms: Diodes; Radar; Traffic surveillance; Electronic monitoring systems; Collision courses; Accident avoidance; Speed sensors; Target detection; Remote sensing; Scanners; Sensors; Doppler effect; Microwave systems; Vehicle detectors; Traffic control devices

HS-011 223 Fld. 2/9**EVALUATION OF DIAGRAMMATIC SIGNING AT CAPITAL BELTWAY EXIT NO. 1**

by Fred R. Hanscom

Virginia Hwy. Res. Council

1971 20p 15refs
Report no. VHRC-71-R6

One conventional sign was replaced by a diagrammatic sign to determine the effect of the new sign on driver behavior. Before and after phases of the study evaluated the effects of the sign in terms of erratic maneuvers, which were

classified into the following types: weaving, hesitating, stopping/backing, and partial weaving. It was concluded that diagrammatic signs can be initially confusing from lack of familiarity, but driver interviews were favorable. It was found that with the new sign weaving decreased, driver behavior was more consistent, no accidents took place during the four month study period, that fewer vehicles stopped or backed, but more hesitated or weaved partially.

Search terms: Highway signs; Driver behavior; Driving tasks; Weaving; Driver confusion; Driver interviews; Sign tests; Sign effectiveness; Sign design; Backing; Statistical analysis; Driver errors; Braking

HS-011 224 Fld. 2/9**A STUDY OF ROADWAY DELINEATION SYSTEMS**

by James I. Taylor

Published in *Highway Research Board Special Report* n107 p81-8 (1970)

Paper sponsored by Committee on Traffic Control Devices.

The primary objectives of this study are to determine the driver's delineation requirements, techniques for determining the effectiveness of delineation treatments, test some of the more promising delineation systems, and develop practical criteria for the selection of delineation treatment systems. The definition of driver's delineation requirements through information-decision-action models is described. These analyses are used to transform driver performance requirements to information requirements.

Search terms: Delineators (traffic); Decision making; Information modeling; Driving task analysis; Pavement markings; Driver vehicle road interfaces; Systems analysis

3/0 HUMAN FACTORS**3/1 Alcohol****HS-011 225 Fld. 3/1; 3/4****EFFECTS OF MODERATE BLOOD ALCOHOL LEVELS ON AUTOMOBILE PASSING BEHAVIOR**

by William O. Light; Charles G. Keiper

Public Health Service

1971 27p 15refs
Report no. ICRL-RR-69-4

Sixteen clinically normal subjects drove in an optical driving simulator with 0.00% and 0.09% blood alcohol levels. Each subject was given 60 trials to make and execute a decision to pass or to continue following a lead car. Times available to complete a pass safely and vehicle speeds were presented in a random manner. During the alcohol condition, subjects attempted and completed significantly more passes but also experienced more accidents. Lateral control of the vehicle was significantly changed, with increased deviation from the center track. Decision-reaction times increased under alcohol, as did error scores on a test of eye-hand coordination. There were also changes in electrocardiograms and emotional stress during the alcohol condition. Results suggest that moderate levels of blood alcohol affect perceptual motor skills, risk taking behavior, and decision processes involved in driving.

Search terms: Passing; Blood alcohol levels; Driver performance under stress; Driver skills; Driving task analysis; Decision making; Risk taking; Driver reaction time; Vehicle control; Vision tests; Alcohol effects; Motor skills; Driving simulators; Gap acceptance; Car following; Driver errors; Driver behavior research; Speed patterns; Electrocardiograms; Emotions

AVAILABILITY: GPO \$0.25

HS-011 226 Fld. 3/1; 3/7; 1/3

A QUALITATIVE ANALYSIS OF WRONG-WAY DRIVING IN TEXAS

by Carroll J. Messer; John D. Friebele; Conrad L. Dudek

Texas A and M Univ. Texas Transp. Inst.

1971 24p

Report no. RR-139-6

In cooperation with Federal Highway Administration.

A questionnaire survey was conducted of state and local highway engineers and law enforcement personnel in an attempt to determine the nature of wrong way driving. In general, these officials considered the greatest problem with respect to wrong way driving to be that of the drinking, drunk, or drugged driver. They also suggested that wrong way driving should be confronted through engineering, enforcement, and education, and that better approaches and techniques for reducing it were desired.

Search terms: Wrong way driving; Questionnaires; Surveys; Traffic law violations; Drinking drivers; Driver intoxication; Drug effects; Drug caused accidents; Accident causes; Accident prevention

3/4 Driver Behavior

HS-011 227 Fld. 3/4; 5/18

DRIVER BEHAVIOUR IN CONTROLLING A DRIVING SIMULATOR WITH VARYING STABILITY

by F. D. Hales; M. P. Jurkat

Loughborough Univ. of Technology (England); Stevens Inst. of Tech.

Published in HS-011 272, *Handling of Vehicles under Emergency Conditions*, 1969 p82-90

5refs

Grant PHS-UI00031
Report no. Paper-2

Presented at a symposium sponsored by Institution of Mechanical Engineers in cooperation with the Univ. of Technology, Loughborough, England, 8 Jan 1969.

The way drivers compensate their driving behavior for degraded vehicle stability is studied. The background of man-machine simulation and the use of driving simulators in the United States are also briefly outlined. The problem was investigated by means of a fixed base driving simulator with a two-degree-of-freedom analogue simulation of vehicle dynamics. An experiment with nine subjects, driving two vehicles, one understeer and one oversteer, simulated to be travelling at 60mph is described, and derived results given. While driving, the vehicles were subjected to a random appearing gust spectra having a maximum amplitude equivalent to 10mph. Methods of assessing overall driving performance and what the drivers did in the two vehicles are developed, and the results, in terms of a driving error and a control response function, are presented. It was found that seven out of nine drivers had a control response function that was higher with the oversteering car. The remaining two subjects had the highest error scores with the understeering vehicle.

Search terms: Driver behavior; Driving simulators; Driving simulation; Vehicle stability; Vehicle control; Understeer; Oversteer; Wind; Test equipment; Driver performance; Driver errors; Driver vehicle interface; Vehicle dynamics; Degrees of freedom

HS-011 228 Fld. 3/4

STUDIES OF THE DRIVER AS A CONTROL ELEMENT. PHASE 3. FINAL REPORT

by C. K. Wojcik; R. W. Allen

California Univ. ITTE

1971 108p 7refs

Report no. UCLA-ENG-7148

In cooperation with California Business and Transportation Agency and Federal Highway Administration

The objective of this research program was to study driver response and performance in four typical driving tasks while driving each of four simulated vehicles with a range of dynamic characteristics. Five young male experienced drivers were used as subjects. The collected data and the analysis of that data contribute toward understanding of the dynamic nature of the driver control process. The four driving tasks simulated were: lane changing; maintaining position in the face of lateral wind gusts; maintaining position with random wing gust disturbance of the vehicle heading angle; and maintaining position with lateral velocity wind gusts introduced into the TV system. Data on driver response and control are presented in tables and charts.

Search terms: Vehicle dynamics; Driver vehicle interface; Man machine systems; Driving task analysis; Young adult drivers; Male drivers; Vehicle control; Lane changing; Wind velocity; Automobile stability; Wind forces; Driving simulators; Driver experience; Lateral force; Statistical analysis; Mathematical models; Driving task models; Automobile modeling

HS-011 229 Fld. 3/4

ACCURACY OF DRIVERS' ESTIMATES OF VEHICLE MILEAGE DRIVEN

by Elizabeth G. House; Patricia F. Waller

North Carolina Univ. Hwy. Safety Res. Center

1971 30p

The purposes of this study were to determine the accuracy of mileage

3/4 Driver Behavior (Cont'd.)**HS-011 229 (Cont'd.)**

estimates provided by a sample of drivers and to determine whether any driver characteristics such as age, sex, and interest in car were associated with accuracy of mileage estimates. Vehicles parked on the University of North Carolina campus were used in the survey, and 505 questionnaires were obtained. There is a significant correlation coefficient of 0.65 between estimated and actual monthly mileage. In general, when the actual mileage is high the estimate is high, and vice versa. About half the drivers estimated their mileage within 200 miles per month. High mileage was associated with lower scores on the responsibility index and higher scores on the interest index, but neither index was related to accuracy of estimates. Males tended to overestimate mileage, females to underestimate. The only driver characteristics which appear associated with accuracy of estimated mileage are sex and amount of driving.

Search terms: Driver mileage; Vehicle mileage; Driver characteristics; Driver age; Driver sex; Male drivers; Female drivers; Surveys; Questionnaires; Statistical analysis; North Carolina

HS-011 230 Fld. 3/4; 5/18**ANALYSIS OF DRIVERS' CONTROL MOVEMENTS**

by John R. McLean; Errol R. Hoffmann

Published in *Human Factors* v13 n5 p407-18 (Oct 1971)

16refs

Driver control movements were studied in two simple steering tasks: driving along a straight lane and on a circular path. In both cases drivers were found to make most of their control movements

within a fairly small frequency range. Spectral analysis shows peaks in spectral density in the range 0.15 to 0.3 Hz. for the circular course and 0.1 to 0.2 Hz. for most cases on the straight course. In a number of trials, secondary peaks occurred in the region 0.35 to 0.6 Hz. An attempt is made to explain these results in terms of the information being used by the driver to steer the car. In the circular course experiment each driver drove the vehicle with three different steering ratios. Change of steering ratio did not show any consistent effect on the form of the spectrum of steering wheel angle.

Search terms: Driving task analysis; Vehicle control; Steering; Spectral analysis; Decision making; Information theory; Steering gear ratios; Mathematical analysis; Frequencies; Yaw; Driver errors; Probability theory

3/5 Driver Education**HS-011 231 Fld. 3/5****DRIVER EDUCATION AND TRAFFIC SAFETY IN NORTH DAKOTA SCHOOLS. ADMINISTRATOR'S AND TEACHER'S GUIDE**

North Dakota Dept. of Public Instruction

n.d. 95p refs

This driver education manual is also intended to be used for safety education in grades 1-12. It covers many aspects of driver education: organization and administration; teacher qualification and certification; instructional planning; topics for instruction; motorcycle safety; snowmobiles; driver education evaluation; teaching aids and equipment; driver education publications; safety education courses; school bus safety; and traffic laws.

Search terms: Driver education manuals; North Dakota; Driver educa-

tion evaluation; High school driving courses; Motorcycle safety; Snowmobiles; Instructors; Curricula; Instruction materials; Child safety education; Traffic laws; School bus safety

3/6 Driver Licensing**HS-011 232 Fld. 3/6****THE WRITTEN DRIVER-LICENSING EXAMINATION AS A TECHNIQUE IN DRIVER SELECTION**

by John A. Conley; Warren J. Huffman

Published in *Highway Research Board Special Report* n107 p15-33 (1970)

5refs

Paper sponsored by Committee on Road User Characteristics.

The purpose of this study was to obtain a valid and reliable instrument capable of testing a person's knowledge and understanding of the material in the Illinois Rules of the Road, and to include sufficient statistical analyses and resulting revisions to provide a sound basis for revising the rules of the road by indicating those areas that are most often misunderstood. The readability of the test forms is discussed.

Search terms: Illinois; Driver license examination; Traffic laws; Statistical analysis; Intelligibility; Driver tests

4/0 OTHER SAFETY-RELATED AREAS**4/1 Codes and Laws****HS-011 233 Fld. 4/1****RISK CONCEPTS IN DANGEROUS GOODS TRANSPORTATION REGULATIONS. SPECIAL STUDY**

National Transp. Safety Board

1971 41p 14refs

Report no. NTSB-ST-71-1

The regulations now governing the transportation of dangerous goods lack clarity and uniformity. They permit variations in the level of risk and the cost of precautionary measures. The adequacy of the weight given to risk reduction for each segment of the populations at risk is uncertain. There is no uniform framework for analyzing the problems of dangerous goods transportation, and the present regulations focus on the inherent nature of the commodities rather than the risks created by their movement. This study examines the development of existing regulations and discusses the need for a new approach. A framework which might be employed for guiding risk identification, evaluation, and reduction is suggested. Adoption of a risk-based framework for dangerous goods regulations is necessary, desirable, and feasible.

Search terms: Accident risk forecasting; Hazardous materials; Transportation of hazardous materials; Accident prevention; Regulations; Federal control; Freight transportation; Systems analysis; Flow charts

AVAILABILITY: NTIS \$3.00

HS-011 234 Fld. 4/1; 2/8; 1/3; 3/4

LEGISLATION AND ENFORCEMENT AS IT RELATES TO THE PREVENTION OF MOTOR VEHICLE TRAFFIC COLLISIONS

by H.E.A. Milward

Royal Canadian Mounted Police

1971 10p

Presented at Third Annual Conference, Canada Safety Council, Saskatoon, Saskatchewan, 9 Jun 1971.

The purposes of traffic laws are described. The factors which cause people to violate traffic laws are varied and complex, including physical disabilities, ignorance of the laws, habitual bad driving habits. Traffic law enforcement affects drivers in both positive and negative ways. The effects of enforcement on driver behavior are discussed.

Search terms: Accident prevention; Traffic law enforcement; Driver behavior; Problem drivers; Driver physical fitness; Driver errors; Traffic law violations; Traffic law violators; Law enforcement effect on accident rates; Driver motivation

4/7 Mathematical Sciences

HS-011 235 Fld. 4/7; 5/22

DYNAMICS OF WHEELED VEHICLES. REPORT 1. A MATHEMATICAL MODEL FOR THE TRAVERSAL OF RIGID OBSTACLES BY A PNEUMATIC TIRE. APPENDIX B. DIGITAL IMPLEMENTATION OF SEGMENTED TIRE MODEL

by N. R. Murphy, Jr.

Army Engineer Waterways Experiment Station

1969 27p

Report no. TR-M-68-1-1; AD-857 163

Procedures for digital implementation of a segmented tire model are presented. Two procedures are required: determination of the segment spring coefficient from measured load-deflection test results and computation of the resultant force vector transmitted to the axle. Digital programs for both procedures are included.

Search terms: Digital computers; Computer programs; Mathematical models; Pneumatic tires; Tire loads; Tire deflection; Analog computers;

Spring rates; Axle load measurements; Fixed objects; Vehicle dynamics;

AVAILABILITY: NTIS as AD-857 163

HS-011 236 Fld. 4/7; 5/18

DYNAMICS OF WHEELED VEHICLES. REPORT 2. IMPLEMENTATION OF WIENER-BOSE THEORY AND APPLICATION TO RIDE DYNAMICS

by A. S. Lessem

Army Engineer Waterways Experiment Station

1971 140p 18refs

Report no. TR-M-68-1-2; AD-723 403

Doctoral dissertation.

Wiener-Bose theory is a theory of nonlinear systems analysis, based upon the use of a series expansion of orthogonal functionals; the purpose is to obtain a mathematical model of standard form of any nonlinear system. Nonlinear systems are identified in terms of a set of "characterizing coefficients," and little knowledge of the physics of the system is required, which makes it attractive for vehicle ride dynamics studies. A computer study was conducted to discern problems of implementation of the theory and a program of testing carried out to ascertain its practicality and utility. A military 3/4 ton truck was used and a Wiener-Bose model having 1,024 coefficients was employed. It was concluded that the theory is capable of satisfactory performance in the analysis of many nonlinear systems. The principal difficulty is the extensive probing effort required for characterizing the system.

Search terms: Nonlinear systems; Systems analysis; Mathematical models; Vehicle dynamics; Computerized simulation; Military vehicles; Truck tests; Topographical

4/7 Mathematical Sciences (Cont'd.)

HS-011 236 (Cont'd.)

factors; Mathematical analysis; Vehicle riding qualities; Flow charts

AVAILABILITY: NTIS as AD-723 403

5/0 VEHICLE SAFETY

5/4 Design

HS-011 237 Fld. 5/4

THE DEVELOPMENT OF AN EXPERIMENTAL SAFETY VEHICLE BY GENERAL MOTORS

by W. B. Larson; J. W. Rosenkrands

General Motors Corp.

1971 38p
Report no. GM-4753

Presented at Second International Technical Conference on Experimental Safety Vehicles, Stuttgart/Sindelfingen, Germany, 16 Oct 1971.

The GM experimental safety vehicle is designed to provide a vehicle with a familiar configuration, aesthetically appropriate to the seventies, and with the "road feel" of a medium size American car. The configuration, structure, and occupant protection systems are described. Occupant kinematics studies with dummies and with computerized simulation are discussed. The results of full scale impact tests are discussed. The objective of the program is to meet or exceed the Department of Transportation's performance requirements for the experimental safety vehicle, emphasizing crashworthiness and occupant protection. Many questions of practicability remain to be solved.

Search terms: Safety cars; Experimental automobiles; Safety design;

Automobile design; Occupant protection; Crashworthiness; Impact tests; Performance characteristics; Computerized simulation; Occupant kinematics; Occupant modeling; Anthropometric dummies

HS-011 238 Fld. 5/4; 4/7

SCALE MODEL STUDY. VEHICLE COLLISION INTO FIXED OBJECT. FINAL REPORT

by R. I. Emori

California Univ. ITTE

1971 54p 6refs
Report no. UCLA-ENG-7106

In cooperation with California Transportation Agency and Federal Highway Administration.

Full-scale automobile collision tests into fixed objects such as sign supports and light poles are expensive and time consuming. The intention of scale model tests is to supplement, but not replace, full-scale tests. If used effectively, model tests will screen out irrelevant full-scale experiments, give an insight into the phenomenon by assembling governing parameters, and guide in the formulation of analytical models. Dimensional analysis was applied to collision phenomena of autos into fixed objects and model rules established. High-speed moving pictures were taken to analyze the motion of the model collision. The speed of the moving pictures was scaled properly from the corresponding full-scale counterpart as performed by California State Highway Division for comparison and validation of the model tests. Comparison to full-scale test results proved that the model test is feasible in automobile collisions into fixed objects and indicated what parameters are governed in the phenomena.

Search terms: Model tests; Simulation models; Impact tests; Parameters; Collision models; High speed photo-

graphy; Motion pictures; Vehicle fixed object collisions; Dimensional analysis; Scale models; Mathematical models; Pole impact tests; Sign supports

HS-011 239 Fld. 5/4

INTERIOR AUTOMOBILE NOISE MEASUREMENTS UNDER VARIOUS OPERATING CONDITIONS

by J. Underwood; L. P. Solomon

Published in *Journal of the Acoustical Society of America* v49 pt1 p407-10 (Feb 1971)

1ref

The problem of noise pollution is receiving increasing attention. Noise levels within various automobiles operating under different conditions on different road surfaces were measured. The test conditions were: idling in an open space; driving at 15 mph over a gravel road; driving in a residential area at 35 mph over smooth asphalt; driving at 70 mph over a smooth concrete expressway. Sound pressure level measurements for each condition are given.

Search terms: Acoustic measurement; Noise exposure; Noise tolerances; Driving conditions; Low speed; High speed; Unpaved roads; Residential streets; Engine operating conditions; Freeway driving; Vehicle noise; Road surfaces; Pavement surface texture; Asphalt pavements; Concrete pavements

HS-011 240 Fld. 5/4

DOTMOBILE-THE ONLY 72 MODEL YOU CAN'T BUY

by Harold M. Nelson

Published in *Automotive Industries* v145 n10 p55-60, 79, 83 (15 Nov 1971)

The prototype experimental safety vehicles are described. Their crashworthiness and safety features are discussed.

Search terms: Safety cars; Experimental automobiles; Safety design; Crashworthiness; Crashworthy bodies; Occupant protection; Automobile safety characteristics; Automobile design

HS-011 241 Fld. 5/4

THE NEW-CAR SMELL

by Kevin P. Shea

Published in *Environment* v13 n8 p2-9 (Oct 1971)

14refs

The smell of new cars is due to a variety of chemicals which are evaporating from the plastics with which the interior is lined. Plasticizers once thought to be inert can escape from numerous plastic products into fluids or into the air. Phthalates, a class of chemicals generically related to thalidomide, are used to make common plastics soft and flexible. They and other plastic components have been implicated in the shock-lung syndrome that follows massive blood transfusions. In laboratory experiments they have affected the nervous system and fetal development of animals. No one knows the effects of exposing millions of people to their vapors.

Search terms: Odorants; Odors; Plasticizers; Plastics; Environmental factors; Phthalates; Health hazards; Animal experiments; Air pollution effect on health; Blood transfusion; Toxicity; Hazardous materials

HS-011 242 Fld. 5/4

THE HYDRAULICS OF OIL SCRAPING

by S. J. Pachernegg

AVL (Austria)

1971 18p 23refs
Report no. SAE-710816

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

This paper is a preliminary treatise of theoretical models and a report of an initial series of experiments covering the scraping effect on film-reducing capabilities of edges and sliders with cross sections similar to those of piston rings. Three basic types of scrapers or sliders are described: The hydrodynamic wedge between inclined, straight, or curved surfaces; a parallel slider that also produces lift; and a blade without a nominal bearing width. The theoretical conclusion of scraping sliders indicates that an oil ring with two geometrically equal rails will only scrape with its leading rail, while the trailing rail will ride a velocity wave without a scraping effect. The validity of this theory has been experimentally supported by tests.

Search terms: Pistons; Hydraulic design factors; Piston rings; Models; Oil rings; Lubrication; Test equipment; Viscosity; Films (coatings); Friction; Sliding contacts; Oil consumption

AVAILABILITY SAE

HS-011 243 Fld. 5/4

COMPLETE AUTOMATION OF A SINGLE CYLINDER DIESEL TEST ENGINE

by F.R. Russell; J.A. Wilson; O.G. Lewis

Esso Res. and Engineering Co.

1971 14p
Report no. SAE-710817

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

A single-cylinder Caterpillar diesel test engine was automated to run under close control without attention. Four types of data were logged on a single, 6-color, 12-point strip chart recorder using only 2 ft/day of specially ruled chart paper. The 16 data points recorded included 8 linear items (0-100 scale) such as pressures, fuel flow rate, speed, torque, and oil level; 5 iron-constantan (0-300 F) temperatures, and a chromelalumel exhaust temperature (875-1300 F); also included were two 4-figure digital values for blowby rate and for fuel rate via an automated balance, each recorded in a unique fashion without a printer. Any conditions outside set limits actuated an alarm. Special equipment protected the engine against sudden, test-running (hot) shutdown if power, air, or fuel supply failed, or if control of critical variables failed.

Search terms: Single cylinder engines; Diesel engines; Data processing; Electronic monitoring systems; Automation; Operating pressure; Engine speeds; Torque; Fuel systems; Operating temperature; Exhaust systems; Blowby; Automatic warning systems; Test equipment

AVAILABILITY: SAE

HS-011 244 Fld. 5/4

TURBOCHARGED DIESEL ENGINE PERFORMANCE AT ALTITUDE

by Jack W. Dennis

Caterpillar Tractor Co.

1971 17p 11refs
Report no. SAE-710822

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

The effect of altitude on the performance of two turbocharged prechamber diesel engines and one direct-injection

5/4 Design (Cont'd.)**HS-011 244 (Cont'd.)**

diesel engine has been studied in a test cell. One prechamber engine was tested at altitudes up to 16,000 ft. The data from these tests are presented and compared with performance at standard conditions. Using the data, an analytical method of predicting the performance of turbocharged diesel engines at altitude has been developed. An iterative computer program, using part-load data taken at standard conditions, is used for the prediction. Comparison is made with the simulated altitude data and with other calculation methods.

Search terms: Turbocharging; Altitude; Engine tests; Diesel engines; Precombustion chamber engines; Computer programs; Forecasting; Engine performance; Simulation models; Fuel consumption; Mathematical models; Air flow rates; Air fuel ratio; Engine speeds; Engine operating conditions

AVAILABILITY: SAE

HS-011 245 Fld. 5/4; 4/7**A NEW LOOK AT SWASH-PLATE DRIVE MECHANISMS**

by E.R. Maki; A.O. DeHart

General Motors Corp.

1971 13p 36refs
Report no. SAE-710829

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

The versatile, compact, and simple swash-plate drive mechanism has been adopted for a variety of applications to give a reliable method of converting

reciprocating motion to rotary motion. Historically, designers have concerned themselves only with the kinematics of swash-plate drives. This paper describes an analysis which combines swash-plate drive kinematics with hydrodynamic-bearing theory so a performance evaluation of the complete mechanism can be made. The predicted operating characteristics have been verified by tests on full-size models. Operating experience has shown the properly designed swash-plate drive system is a competitive method for converting reciprocating motion into rotary motion. A comprehensive bibliography of swash-plate drive literature is included.

Search terms: Drive systems; Mathematical analysis; Hydrodynamics; Bearing tests; Internal combustion engines; Stirling engines; Pistons; Motion; Kinematics; Performance characteristics

AVAILABILITY: SAE

HS-011 246 Fld. 5/4**DESIGN AND DEVELOPMENT OF FLUIDS FOR TRACTION AND FRICTION TYPE TRANSMISSIONS**

by M. W. Haseltine; I. N. Duling; P. E. Hagstrom; R. J. Stenger; D. S. Gates

Sun Oil Co.; Delaware County Community Coll.

1971 7p 11refs
Report no. SAE-710837

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

The traction coefficients for a series of hydrocarbon fluids were determined and related to their structural and rheological properties. A continuous relationship was found between the coefficient of traction of the poly(1-olefin) fluids and the number of carbon atoms in

the monomer with a maximum at poly(1-butene). A family of gem-dimethyl substituted structures was found to exhibit unusually high-traction coefficients for viscosity index levels. The manner in which certain types of additives affect traction was determined in the development of a formulated traction fluid. Various standard tests show that the formulated traction fluid has very good oxidation stability, provides excellent wear and rust and corrosion protection and offers comparable bearing fatigue life to a conventional automatic transmission fluid. The effect on seals is also similar to that of an ATF. Field tests indicate that the formulated traction fluid will operate effectively in traction transmissions, and conventional automatic transmissions; and will lengthen service life of limited slip differentials and roller clutches.

Search terms: Transmission fluids; Hydrocarbons; Transmissions; Automatic transmissions; Rheological properties; Physical properties; Viscosity; Oxidation; Wear resistance; Corrosion resistance; Fatigue life; Traction; Coefficient of friction

AVAILABILITY: SAE

HS-011 247 Fld. 5/4**ADHESIVES FOR NAVAL APPLICATIONS**

by Lawrence C. Ritter

Naval Air Devel. Center

1972 14p 12refs
Report no. SAE-720120

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

Navy research and development programs dealing with adhesives and adhesive bonding are presented, with respect to their objectives, approach, findings, and future efforts. Specifically discussed are: stress corrosion failure of

bonded aluminum; adhesives for use with difficulty bonded nonmetallic surfaces (polymers) and rocket propellants; and bonding and joining techniques for advanced filamentary graphite composites. Stress corrosion experimentation demonstrated the accumulation of corrosion products on the exposed aluminum. A possible cause for the formation of weak boundary layers is suggested, and a proposed mechanism for stress corrosion cracking is presented. Forty standard adhesives were investigated in the study of difficulty bonded surfaces and rocket propellant. The character of several of these adhesives is discussed with respect to shear strength, softening temperature, and failure under load. Epoxy/graphite composite, joined to itself and to other metallic members by adhesive bonding and bolting, was investigated to assess the material aspects with respect to the strength of the joint. Lack of reliable data presently limits full utilization of adhesive bonding.

Search terms: Adhesives; Bonding; Aluminum; Stress corrosion; Corrosion; Shear stress; Tensile strength; Adhesion; Graphite; Polymers; Thermal stresses; Failures; Epoxy resins; Propellants

AVAILABILITY: SAE

HS-011 248 Fld. 5/4

LUBRICANT ASH CONTENT AND SURFACE IGNITION IN GASOLINE ENGINES

by J. V. D. Wilson; G. J. J. Jayne

Cooper (Edwin) and Co. Ltd. (England)

1972 13p 8refs
Report no. SAE-720153

Presented at the Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

A testing technique has been evolved using typical United States and European production multicylinder

gasoline engines to assess the effect of quantity and type of lubricant ash on surface ignition. Results indicate that, for a given metal type of additive, high-ash lubricants have a greater propensity to surface ignition than corresponding low-ash blends. Tests at a constant ash level show magnesium-based lubricants to be less prone to such problems than barium- or calcium-based lubricants.

Search terms: Surface ignition; Ash content; Automobile engines; Lubricant additives; Knock; Detergents; Antioxidants

AVAILABILITY: SAE

HS-011 249 Fld. 5/4

UNIQUE 2 IN³ DISPLACEMENT ENGINE FOR OEM

by Cecil T. Cookson

O and R Engines, Inc.

1972 10p 2refs
Report no. SAE-720154

Presented at the Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

A market existed in the 2-cycle engine field for an internal combustion engine in the 1-1/2 to 2-1/2 in³ displacement range for the original equipment manufacturer. The engine had to be lightweight, compact, low in manufacturing costs, and yet offer high power output and continuous operation. For this market, O & R Engines, Inc. designed the 2-CID Model 20 engine. The design filled a further requirement of the OEM by providing the flexibility of component design and arrangement. This paper discusses these design aspects.

Search terms: Internal combustion engines; Two stroke cycle engines; Engine design; Single cylinder engines; Flexibility

AVAILABILITY: SAE

HS-011 250 Fld. 5/4

THE NEW JAGUAR 12-CYLINDER ENGINE

by Walter T. F. Hassan

British Leyland Motor Corp. Ltd.

1972 26p
Report no. SAE-720163

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

A new Jaguar engine, incorporating 12 cylinders in 60 deg Vee formation and using aluminum for most of its construction, was announced in conjunction with a new "E"-type, Series "3" sports car in March 1971. This paper is intended to describe this engine and to discuss some of the more interesting design features. The background history of the previous XK engine is presented, together with the reasons for designing the new engine. The design features single camshafts per cylinder bank, with valves in line in a flat combustion chamber, together with a new Lucas transistorized ignition system. A technical specification, together with relevant illustrations, is contained in the Appendixes.

Search terms: High powered engines; Engine design; Combustion chamber design; Ignition systems; Camshafts; Cylinders; Engine operating conditions; Valves; Performance characteristics; Crankshafts; Crankcases; Compression ratio; Fuel injection

AVAILABILITY: SAE

HS-011 251 Fld. 5/4

THE DODGE COLT ENGINE AND RELATED ENGINES

by Kazuo Hashimoto; Hirokazu Nakamura

Mitsubishi Motors Corp. (Japan)

5/4 Design (Cont'd.)

HS-011 251 (Cont'd.)

1972 21p 1ref

Report no. SAE-720164

Presented at Automotive Engineering Congress, Detroit, 19-14 Jan 1972.

This paper outlines the design features of the 4-cyl, overhead camshaft 1.6-liter Dodge Colt engine together with four other single and double overhead camshaft engines in the same family. These engines have been developed for high performance with a compact size and reduced weight. The Dodge Colt engine, in particular, has been designed to be in compliance with stringent 1972 United States emissions standards. Emission controls achieved with this engine, such as improved combustion chamber design of small surface/volume ratio and various control systems, are described in some detail.

Search terms: Overhead camshaft engines; Engine design; Engine size; Emission standards; Combustion chamber design; High powered engines; Engine operating conditions; Engine speeds; Air fuel ratio; Exhaust emission control devices

AVAILABILITY: SAE

13refs

The application of the constant temperature hot-wire anemometer to the measurement of instantaneous gas velocity in the pre-chamber of a motored I. C. engine is shown to be possible. The correction of the anemometer output to allow for the operation of the wire at conditions greatly removed from those of a wind tunnel calibration are discussed. The variation of gas velocity at a fixed point in the pre-chamber with variation of engine compression ratio and engine speed was studied.

Search terms: Internal combustion engines; Combustion chambers; Anemometers; Air flow rates; Gas motion; Engine speeds; Compression ratio; Wind tunnel tests; Engine operating conditions; Mathematical analysis; Heat transfer

HS-011 253 Fld. 5/6

KNOCK LIMITS AND PERFORMANCE OF SOME GASEOUS FUELS IN A SUPERCHARGED SPARK-IGNITION ENGINE

by W. J. D. Annand; S. J. Sulaiman

Published in *Institution of Mechanical Engineers Proceedings* 1970-71 v185 n62/71 p857-67

18refs

Observations of knock limits, in terms of ignition time for borderline knock, are presented for methane and propane at a range of supercharge conditions up to 9 lbf/in² boost, in a spark ignition engine of 105 mm bore running at speeds of 600 and 920 rpm, with compression ratios of 7.7/1 and 9.5/1. Associated measurements of output and economy are given. Less extensive observations on a butane fuel, and on methane-propane and propane-butane mixtures, are also included. From an examination of computed temperature-pressure histories in the unburned portion of the mixture, it is found that the knock limited igni-

tion advance on the propane fuel at chemically correct mixture can be closely predicted over the full range of operating conditions covered, by the attainment of a certain critical value of a simple parameter.

Search terms: Knock; Spark ignition engines; Engine performance; Engine operating conditions; Superchargers; Methane; Propane; Ignition timing; Engine speeds; Compression ratio; Fuel economy; Power output; Fuel mixtures; Butane; Unburned fuels; Parameters; Operating temperature; Operating pressure; Pressure time histories; Mathematical models

HS-011 254 Fld. 5/6; 3/12

CARBON MONOXIDE AND HUMAN VIGILANCE. A DELETERIOUS EFFECT OF PRESENT URBAN CONCENTRATIONS

by Steven M. Horvath; Thomas E. Dahms; James F. O'Hanlon

Published in *Archives of Environmental Health* v23 n5 p343-7 (Nov 1971)

16refs

Grant AFOSR-69-1653

This study was conducted to determine whether carbon monoxide is responsible for deterioration of vigilance in men breathing polluted air. Ten subjects were exposed to CO levels approximating the average (26 ppm) and peak (111 ppm) levels found while driving in urban traffic. During the last hour of each exposure the subjects undertook a standard test of visual vigilance. The same test was also undertaken while breathing air without CO. Blood carboxyhemoglobin levels were measured before and after the tests. Heart rates and minute ventilatory volumes were also measured. Results showed that vigilance was impaired by breathing 111 ppm CO, which raised the average COHb level to 6.6%. Heart rates and minute ventilatory volumes were not affected.

5/6 Fuel Systems

HS-011 252 Fld. 5/6

THE MEASUREMENT OF AIR VELOCITY IN A MOTORED INTERNAL COMBUSTION ENGINE USING A HOT WIRE ANEMOMETER

by H. Hassan; J. C. Dent

Published in *Institution of Mechanical Engineers Proceedings* 1970 v185 n50/71 p583-91

Search terms: Carbon monoxide poisoning; Carboxyhemoglobin; Blood carbon monoxide levels; Vision tests; Heart rate; Air pollutant exposure tolerances; Air pollution effect on health; Vigilance tasks; Vigilance tests; Visual degradation

Laboratory tests; X ray spectrometers; Spectral analysis

AVAILABILITY: SAE

HS-011 256 Fld. 5/6

COMBUSTION AND EMISSION FORMATION IN THE STIRLING ENGINE WITH EXHAUST GAS RECIRCULATION

by Stephen R. Davis; Naeim A. Henein; Richard R. Lundstrom

Wayne State Univ.

1971 15p 18refs
Report no. SAE-710824

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meeting, St. Louis, 26-29 Oct 1971.

The combustion and emission formation in continuous combustion burners have been studied both theoretically and experimentally. The theoretical study is concerned with the combustion and emission formation in idealized sprays in quiescent air. The effects of the spray rotation and the air axial and radial velocities have been examined. A model has been developed for the emission formation in an actual Stirling engine. This model showed that the incomplete combustion products are primarily formed in the heterogeneous eddies zone near the burner walls. In this region, surface combustion takes place. The nitric oxide is primarily formed in the premixed-eddies zone where micro-volume combustion is believed to take place. The experimental results deal with the effect of diluting the charge by using excess air or exhaust-gas recirculation on performance and emissions. The emissions measured are the nitric oxide, carbon monoxide, unburned hydrocarbons, and carbon. The tests were conducted at 5 and 8 hp. The effect of residence time in air preheater on the different emissions has been assessed. It was shown that the increase in residence

time was effective at light loads and low air-fuel ratios in reducing exhaust emissions. Exhaust-gas recirculation was effective in reducing the nitric oxide emissions up to approximately 40% recirculation. However, the thermal efficiency of the Stirling engine decreases with the increase in the percentage exhaust-gas recirculation.

Search terms: Mathematical models; Stirling engines; Exhaust gas recirculation; Combustion; Air flow; Simulation models; Nitric oxide; Charge dilution; Engine performance; Carbon monoxide; Hydrocarbons; Carbon; Unburned fuels; Exhaust emissions reactivity; Exhaust emission tests; Air fuel ratio; Exhaust emission control; Thermal factors; Engine operating conditions; Fuel injection; Fuel sprays

AVAILABILITY: SAE

HS-011 257 Fld. 5/6

EXHAUST EMISSION CHARACTERISTICS OF HYBRID HEAT ENGINE/ELECTRIC VEHICLES

by M.G. Hinton, Jr.; T. Iura; W.U. Roessler; H.T. Sampson

Aerospace Corp.

1971 13p 9refs
Report no. SAE-710825

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

As part of a study to ascertain the feasibility of hybrid heat engine/electric automotive vehicles, exhaust emissions were calculated to determine both the state-of-the-art and the potential emission capability of vehicles incorporating the battery/heat engine powerplant. Vehicle emissions were determined for four vehicle classes: full-size family car, small commuter car, delivery/postal van, and the city bus. Specific mass emission data (in terms of gm/bhp-hr) were

HS-011 255 Fld. 5/6

APPLICATION OF THE SCANNING ELECTRON MICROSCOPE/X-RAY SPECTROMETER TO AUTOMOBILE EXHAUST PARTICULATES

by Lois Settlemeier

Dow Chemical Co.

1970 17p
Report no. SAE-710637

Presented at Joint Meeting of SAE Mid-Michigan Section and American Chemical Society Midland Section, Midland, Michigan, 24 Oct 1970.

The advantages of using the scanning electron microscope (SEM) to characterize automotive particles are described. The sample, collected using an Andersen sampler, is bombarded with electrons and the resultant x-rays are analyzed with an energy dispersive spectrometer. After many particles were observed, classifications were made for individual particles of one structural type greater than 3 μ in size; agglomerates, single masses of particles less than 1 μ ; fines, particles of 500-1000 Å; and atypical particles. It is felt that with the advances in methods and technology this procedure will provide a strong basis for future sampling characterization and identification.

Search terms: Particle size analysis; Particulate air pollutants; Scanning electron microscopes; Spectroscopic analysis; Exhaust emission tests;

5/6 Fuel Systems (Cont'd.)

HS-011 257 (Cont'd.)

gathered for the spark ignition, diesel, gas turbine, Rankine cycle, and the Stirling cycle engines. Data inputs required the determination of steady-state mass emission data at rated-load as well as part-load operating conditions. These data were utilized to calculate the exhaust emission characteristics of the passenger car and commuter car driving over the Federal LA-4 driving cycle. Emission data for the delivery van and city bus were calculated over an arbitrarily selected driving cycle. The results indicate that marked reductions in emissions can be obtained with the spark ignition engine operating at lean air-fuel ratios, which is permitted by the steady-state operation characteristic of the hybrid. For the future, the gas turbine shows promise of further emission reductions, and the diesel engine shows promise in certain areas.

Search terms: Electric automobiles; Hybrid engines; Hybrid automobiles; Feasibility studies; Exhaust emission tests; Vehicle size; Compact automobiles; Buses; Trucks; Spark ignition engines; Diesel engines; Gas turbine engines; Rankine cycle engines; Stirling engines; Steady state; Commuting automobiles; Driving conditions; Air fuel ratio; Exhaust emission control; Engine operating conditions

AVAILABILITY: SAE

HS-011 258 Fld. 5/6

EFFECTS OF COMPRESSION RATIO CHANGES ON EXHAUST EMISSIONS

by A.E. Felt; S.R. Krause

Ethyl Corp.

1971 11p
Report no. SAE-710831

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 October 1971.

Results of a comprehensive test program using a 1969 383-CID V-8 engine at two compression ratios (9.5:1 and 7.6:1) are reported. Compression ratio changes were effected by piston changes only. Except for necessary ignition timing modifications, no other changes were made in the engine. Effects of compression ratio changes on exhaust emissions and fuel consumption were studied in steady state dynamometer tests and in vehicle tests. In steady state dynamometer tests, NO and CO emissions were unchanged, hydrocarbons decreased, and fuel consumption increased when equal power was developed at both compression ratios. In vehicle tests, NO and CO emissions were unchanged and hydrocarbons increased. Tests in this engine show that decreasing compression ratio cannot be justified on the basis of reducing NO emissions.

Search terms: V 8 engines; Engine tests; Compression ratio; Pistons; Ignition timing; Engine modification; Exhaust emission tests; Fuel consumption; Power loss; Dynamometers; Hydrocarbons; Carbon monoxide; Nitrogen oxides; Nitric oxide; Mathematical models; Road tests; Laboratory tests

AVAILABILITY: SAE

HS-011 259 Fld. 5/6

EMISSION CHARACTERISTICS OF NATURAL GAS AS AN AUTOMOTIVE FUEL

by R. D. Fleming; J. R. Allsup

US Bureau of Mines

1971 8p 8refs
Report no. SAE-710833

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

A study of natural gas as a low-pollution automotive fuel was conducted using a single-cylinder engine, a multicylinder engine, and six vehicles. Results showed that the light-load, lean-limit misfire region of natural gas begins at an air-fuel ratio between 140-150% of stoichiometric. Changes in ignition timing significantly influenced emissions of nitrogen oxides and hydrocarbons but had little effect on carbon monoxide emission. Lower emissions can be achieved (by adjustment) with current design engines, but with heavy penalty to engine performance. Emissions from vehicles fueled with natural gas are virtually unaffected by temperature change within the range 20-100 F. Natural gas exhaust is estimated to be 22-25% as reactive as gasoline exhaust.

Search terms: Natural gas automobiles; Air fuel ratio; Ignition timing; Nitrogen oxides; Hydrocarbons; Carbon monoxide; Engine tests; Engine design; Exhaust emission tests; Single cylinder engines; Stoichiometry; Engine performance; Engine operating conditions; Mathematical analysis

AVAILABILITY: SAE

HS-011 260 Fld. 5/6

SURVEY OF NATIONWIDE AUTOMOTIVE EXHAUST EMISSIONS AND PCV SYSTEM CONDITIONS—SUMMER 1970

by F.L. Voelz; E.W. Onyon; R.M. Oust; W.C. Rusnack; J.S. Segal; B.G. Gower

Atlantic Richfield Co.

1971 12p 7refs
Report no. SAE-710834

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

Results of a nationwide vehicle exhaust emission survey and PCV system check are presented. More than 75,000 vehicles were tested in 15 metropolitan areas. Hydrocarbon and carbon monoxide emissions are summarized at idle and 2500 rpm (free running), and the condition of the PCV system is correlated with vehicle age. Vehicle distribution curves for hydrocarbon and carbon monoxide emissions are shown for selected year groupings of American and foreign-built vehicles. The effect of carburetor adjustment (air-fuel ratio, rpm) on idle emissions is demonstrated for those 32% of the total vehicles for which adjustments were made.

Search terms: Exhaust emissions; Vehicle air pollution; Air pollution emission factors; Exhaust emission tests; Hydrocarbons; Carbon monoxide; Vehicle age; Carburetors; Air fuel ratio; Engine speeds; Positive crankcase ventilation; Engine operating conditions; Automobile tests; Engine tests

AVAILABILITY: SAE

HS-011 261 Fld. 5/6

SHORT-TRIP ENGINE OIL RUST TESTING

by James P. Bernard

Ford Motor Co.

1971 8p 3refs
Report no. SAE-710839

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

Twenty vehicles were tested on a short-trip winter driving schedule in order to study the effects of some engine, oil, and fuel variables on engine rusting. The results show that: rusting in the V8 engines was worse than in the 6-cyl engines; the effect of exhaust gas recirculation is small but it does increase

rusting; unleaded fuel reduces engine rusting; ashless oil formulations may not be satisfactory even with unleaded fuels; present laboratory engine tests may not be adequate to predict oil performance for six months of severe winter service.

Search terms: Engine wear; Engine tests V 8 engines; Exhaust gas recirculation; Lead free gasoline; Laboratory tests; Winter driving; Engine operating conditions; Fuel composition; Trip length; Oils; Variables; Oxidation; Ash content; Cold weather tests

AVAILABILITY: SAE

HS-011 262 Fld. 5/6

ROLE OF LEAD ANTIKNOCKS IN MODERN GASOLINES

by Alden J. Pahnke; Wilfred E. Bettoney

Du Pont de Nemours (E. I.) and Co.

1971 34p 68refs
Report no. SAE-710842

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

The role of lead antiknocks in modern gasolines is discussed in terms of engine-fuel relationships. Exhaust emission characteristics of leaded and unleaded gasolines are compared in terms of both gaseous and particulate constituents. The effect of removing lead from gasoline on engine cleanliness, exhaust valve seat recession, octane requirements and octane requirement increase is assessed. Extensive use is made of published information and some new information is presented. It is apparent that the use of lead antiknocks in gasoline produces effects on engine performance and exhaust emission characteristics which are both positive and negative in nature. Much more information is needed, particularly in terms of future vehicles equipped with advanced control systems,

to determine the optimum fuel composition. In view of this situation, the best course of action appears to be one which provides for maximum flexibility, both in systems to meet future emissions and in the use of lead antiknocks.

Search terms: Leaded gasoline; Lead free gasoline; Engine operating conditions; Exhaust emissions; Lead; Fuel additives; Knock; Exhaust valve wear; Octane requirements; Engine performance; Fuel composition; Hydrocarbons; Exhaust emissions reactivity; Photochemical reactions; Particulate air pollutants; Vehicle operating costs

AVAILABILITY: SAE

HS-011 263 Fld. 5/6

THE EFFECTS OF TEL ON OXIDATION IN AN EXHAUST MANIFOLD REACTOR—A SINGLE-CYLINDER ENGINE STUDY

by Richard C. Schwing

General Motors Corp.

1971 15p 8refs
Report no. SAE-710844

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

In rich-exhaust manifold reactors, complete oxidation of carbon monoxide (CO) and hydrocarbons (HC), generally characterized by luminous conditions and high temperatures, is desirable. Some of the conditions necessary for luminous oxidation in an insulated exhaust reactor have been explored with a single-cylinder engine using both leaded and unleaded isooctane. Threshold-reactor air-injection rates required for luminous oxidation in the reactor were determined for engine air-fuel ratios (A/F) between 11.2 and 14.1.

5/6 Fuel Systems (Cont'd.)

HS-011 263 (Cont'd.)

Leaded isooctane produced higher unburned HC concentrations in the exhaust than unleaded isooctane when injection air was introduced as well as when no air was added. In addition, oxidation of CO in the reactor was hindered in the tests with leaded isooctane. During one set of experiments, conditions were such that luminous oxidation in the reactor was achieved with the unleaded fuel, but was not achieved with the leaded fuel. In warmup studies, a longer time was required to reach luminous conditions in the reactor when leaded isooctane was used in the engine than when unleaded isooctane was used.

Search terms: Rich fuel mixtures; Exhaust manifold reactors; Carbon monoxide; Hydrocarbons; Oxidation; Single cylinder engines; Leaded gasoline; Lead free gasoline; Air fuel ratio; Isooctane; Engine operating conditions; Air injection; High temperature; Unburned fuels; Exhaust emissions; Tetraethyl lead; Mathematical models

AVAILABILITY: SAE

HS-011 264 Fld. 5/6

STUDIES OF CATALYST DEGRADATION IN AUTOMOTIVE EMISSION CONTROL SYSTEMS

by Joseph E. Hunter

General Motors Corp.

1972 8p 3refs
Report no. SAE-720122

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

Reactions of sulfur, present in small amounts in gasoline, with catalyst and

catalyst support materials are discussed. GMR studies have shown that sulfur accumulates in catalysts and support materials at temperatures of 600-1300 F under both oxidizing and reducing conditions. Partial sulfur release has been observed at 1200-1600 F. Concurrent with sulfur accumulation, there is a marked reduction in the carbon monoxide (CO) reactivity of noble metal, promoted and base metal catalysts. Lesser highly variable effects on hydrocarbon (HC) reactivity were noted. Studies of nitrogen oxide (NO_x) reducing, noble metal catalysts also showed an adverse effect of sulfur accumulation on the NO_x reactivity. These results indicate that steps must be taken to reduce or eliminate sulfur poisoning of automotive emission control systems. Approaches for achieving this objective are discussed.

Search terms: Chemical reactions; Exhaust emission control devices; Sulfur; Nitrogen oxides; Hydrocarbons; Carbon monoxide; Catalyst poisoning; Catalysts; Engine operating conditions; High temperature; Laboratory tests

AVAILABILITY: SAE

5/10 Lighting Systems

HS-011 265 Fld. 5/10

THE VALUE OF AN ACCELERATOR RELEASE SIGNAL

by Rudolf G. Mortimer

Published in *Human Factors* v13 n5
p481-6 (Oct 1971)

11refs
Contract FH-11-6936

The value of a signal shown on the rear of an automobile when the accelerator is released was investigated by measuring: the magnitude of decelerations in coasting passenger cars; the ability of drivers to detect coasting of a vehicle they are

following; and coasting periods used by a number of drivers on various trips. Coasting decelerations of a sample of passenger vehicles did not exceed 3 ft/sec². The driver's sensitivity, the change in spacing necessary to detect coasting of a lead vehicle, was a direct function of the initial headway. Instrumentation of a motor-pool automobile showed that most coasting durations were between 0.5 and 5 sec. with speed reductions of less than 4 mph. Release of the accelerator pedal was followed by braking on less than 50% of the coasting occasions. It was concluded that a coasting signal could not reliably indicate that braking would follow and was largely unnecessary for detection of coasting, but could aid in reducing the development of critical conditions when coasting periods exceed about 5 sec. A signal given only when coasting duration exceeds 5 sec. would not occur frequently and would provide valid information on most occasions.

Search terms: Deceleration lamps; Warning signals; Deceleration; Velocity perception; Driver performance; Coast down tests; Driving tasks; Headway variances; Road tests; Signal lamps; Deceleration lamps; Warning lights; Speed detection; Coasting

5/14 Occupant Protection

HS-011 266 Fld. 5/14; 4/7

A THEORETICAL APPROACH TO AIR BAG SHOCK ABSORBER DESIGN

by A. C. Browning

England Ministry of Aviation

1964 71p
Report no. CP-751

A simple theory of the compression of a cylindrical air bag shock absorber has been studied in detail by means of over 1,000 step-by-step integrations. Many features of practical air bag performance

have been reproduced, and data charts are given which indicate the design parameters for useful bags. From these charts the effect of bag loading, height, orifice area, and speed of descent can be appreciated. The use of a strong patch covering the orifice, bursting at several pounds per square inch pressure, has been investigated but gives little change in performance. If an extensible fabric is employed an increase in both bag height and orifice area is necessary. Bags of very high or very low loading are found to be inefficient, and it is concluded that air bags are most suitable at a loading of 150 to 200 lb. per square foot. The theory does not take account of the wind speed which, if more than about 6 ft/sec, could cause the load to drift partly off the bags, reducing the retardation.

Search terms: Air bag inflation pressure; Air bag inflation time; Air bag restraint systems; Shock absorbers; Performance characteristics; Parameters; Loading tests; Load bearing capacity; Wind velocity; Orifice flow; Mathematical analysis; Mathematical models

AVAILABILITY: NTIS

HS-011 267 Fld. 5/14

RESTRAINT SYSTEM EFFECTIVENESS

by W. D. Nelson

General Motors Proving Ground

1971 23p 5refs
Report no. GM-Eng-Pub-4775

Prepared for presentation to 15th annual conference, American Association for Automotive Medicine, 20-23 Oct 1971.

The effectiveness of lap-shoulder belts in reducing injury severity was studied. About 40% of passenger cars registered in the United States are equipped with

lap and shoulder belt systems, but few persons use them. By 1973 about 62% of the car population will be equipped with these systems, but by 1983 it is projected that only 11% of the cars will have them, and that passive restraint systems will have replaced them. The motoring public may develop a false sense of security during the transitional period, thus increasing the injury risk from failure to use active restraints. The use of lap-shoulder belt systems should be encouraged. Injury reduction benefits that have occurred in field accidents are discussed.

Search terms: Restraint system effectiveness; Shoulder harnesses; Seat belt effectiveness; Restraint system usage; Shoulder harness usage; Seat belt usage; Passive restraint systems; Injury prevention; Injury severity; Accident case reports; Injury case reports

5/15 Propulsion Systems

HS-011 268 Fld. 5/15

ELECTRIC CAR SIMULATION

by Leonard P. Gau

Published in *Institute of Environmental Sciences, Proceedings* p237-42 (1969)
1ref

Presented at 15th annual Technical Meeting of the Institute of Environmental Sciences, Anaheim, Calif., 20-24 Apr 1969.

Alternations to a conventional passenger car give it the acceleration and range performance characteristics of a battery powered electric car. Acceleration tailoring is accomplished by engine and drivetrain modifications. Range performance is duplicated by a computer designed to measure power consumption and impose those constraints characterizing electric propulsion in the foreseeable future. This simulator is

useful for conducting experiments designed to yield knowledge about a broad spectrum of acceptable performance limitations which might be imposed by safety considerations and attitudes of the motoring public.

Search terms: Automobile modifications; Simulation models; Automobile modeling; Acceleration; Electric automobile range; Performance characteristics; Electric automobile design; Computerized simulation; Engine modification; Drivetrains

HS-011 269 Fld. 5/15

DESIGN ASPECTS OF A 10KW, MULTI-FREQUENCY, CYCLO-CONVERTER/HIGH-SPEED ALTERNATOR, ELECTRICAL POWER SYSTEM

by John C. Guyeska; Martin F. Drlik; Gerald H. Horstman

Lear Siegler, Inc.

1972 12p 6refs
Report no. SAE-710567

Presented at the SAE Mid-Year Meeting, Montreal, 7-11 Jun 1971.

The purpose of this paper is to describe some of the electrical power conversion and mechanical design aspects of a light-weight cycloconverter/high speed alternator, electrical power system for Army usage. Some of the pertinent design aspects discussed are the development of equivalent converter/alternator circuits to establish alternator rating, and some design considerations of a high speed, solid rotor alternator.

Search terms: Turboalternators; High speed; Electric system design; Electric power generation; Electric converters; Alternators; Frequencies; Mathematical analysis

AVAILABILITY: SAE

5/15 Propulsion Systems (Cont'd.)

HS-011 270 Fld. 5/15; 5/6

THE VARIABLE-DISPLACEMENT ENGINE: AN ADVANCED CONCEPT POWERPLANT

by Harvey W. Welsh; Charles T. Riley

Thermo Mechanical Systems Co.

1971 18p 2refs
Report no. SAE-710830

Presented at National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, 26-29 Oct 1971.

This paper describes a new concept of reciprocating engine which permits the control of displacement and the clearance volume as a function of power in order to better match the engine to vehicle power requirements. It is applicable to both diesel and otto-cycle engines and shows promise for increased efficiency, especially for the otto-cycle engine. This engine also has the potential of improving engine emissions characteristics.

Search terms: Variable displacement engines; Reciprocating engines; Diesel engines; Otto cycle engines; Engine performance; Engine design; Exhaust emissions; Power output; Engine speeds; Engine tests

AVAILABILITY: SAE

5/18 Steering Control System

HS-011 271 Fld. 5/18; 4/7

TRANSIENT MOTION OF AN AUTOMOBILE UNDER A STEERING INPUT

by Edward A. Saibel; Shang-Li Chiang

Published in *High Speed Ground Transportation Journal* v5 n3 p451-71 (Fall 1971)

8refs

A theoretical model of the automobile with eleven degrees of freedom and the equations of motion based on it are established. Nonlinear characteristics of tire and suspension systems are introduced by treating the sprung mass as mounted to the wheels by means of springs and dash pots. An attempt is made to develop a man-vehicle-road system so that the transient response of the automobile can be examined for front wheel, rear wheel, and four wheel drive vehicles under a variety of maneuvers with different road conditions. Comparison is shown between understeering and oversteering conditions. Lateral acceleration, longitudinal acceleration, lateral tire force, vertical tire force, pitch angle, roll angle, rotational angle, deflection of tires and suspensions, slip angles, and instantaneous velocity of the automobile are calculated. The braking maneuver is also discussed.

Search terms: Mathematical analysis; Mathematical models; Degrees of freedom; Equations of motion; Automobile modeling; Simulation models; Nonlinear systems; Suspension systems; Tire characteristics; Driver vehicle road interfaces; Man machine systems; Driving conditions; Vehicle mass; Four wheel drives; Front wheel drives; Rear wheel drives; Oversteer; Understeer; Steering; Acceleration; Tire forces; Pitch; Roll; Slip; Braking; Velocity; Motion; Tire deflection; Deflection

HS-011 272 Fld. 5/18; 4/7; 3/4

HANDLING OF VEHICLES UNDER EMERGENCY CONDITIONS

by N. F. Barter; C. J. Cooke; H. J. Burnham; J. S. Webber

Published as *Institution of Mechanical Engineers Proceedings 1968-69* v183 pt3H

1969 129p

Papers presented at a symposium sponsored by Institution of Mechanical Engineers in cooperation with the Univ. of Technology, Loughborough, England, 8 Jan 1969. Includes HS-011 227; HS-011 273 through 277.

Symposium papers are presented on: skidding of vehicles due to locked wheels; vehicle behavior in combined cornering and braking; tire forces as functions of cornering and braking slip on wet road surfaces; dynamics of automobiles during simultaneous cornering and ride motions; driver behavior in controlling a driving simulator with varying stability; and a new loose inverse procedure for matching tires and car using a mathematical model. Discussion of the papers presented at each session of the symposium are included, as well as general discussion, authors' replies, a list of delegates, and author/participant and subject indexes.

Search terms: Conferences; Skidding; Vehicle handling; Cornering; Braking; Vehicle dynamics; Driver behavior; Tire forces; Mathematical models; Vehicle stability; Driving simulation

HS-011 273 Fld. 5/18; 4/7

SKIDDING OF VEHICLES DUE TO LOCKED WHEELS

by W. T. Koiter; H. B. Pacejka

Technische Hogeschool, Delft (Netherlands)

Published in HS-011 272, *Handling of Vehicles under Emergency Conditions*, 1969 p3-18

8refs
Report no. Paper-1

Presented at a symposium sponsored by Institution of Mechanical Engineers in cooperation with the Univ. of Technology, Loughborough, England, 8 Jan 1969.

Two studies are combined in this paper. A basic assumption of the whole investigation is to ignore the height of the center of gravity of the vehicle above the road surface. In the first study, the drift angle of rolling wheels under lateral forces and the possible lateral skidding of rolling wheels were also ignored. The equations of motion may then be reduced to a non-linear second-order system of ordinary differential equations. The second study has been refined by proper allowance for the drift angle of rolling wheels under the action of lateral forces, for the possibility of sideways skidding of rolling wheels, and for braking action on the rolling wheels. The equations of motion then reduce to a third-order system which may be solved in closed form in the linear case of small deviations from a rectilinear motion. It appears that the drift angle of rolling wheels under the action of lateral forces leads to a small increase of the critical speed and to a significant reduction of the danger when the critical speed is exceeded. A digital computer was employed to obtain results for non-linear equations for larger deviations from a rectilinear motion.

Search terms: Wheel locking; Skidding; Equations of motion; Vehicle stability; Lateral force; Nonlinear systems; Linear systems; Vehicle handling; Coefficient of friction; Mathematical models; Braking; Speed; Slip; Parameters

HS-011 274 Fld. 5/18; 4/7

AN ANALYSIS OF THE DYNAMICS OF AUTOMOBILES DURING SIMULTANEOUS CORNERING AND RIDE MOTIONS

by R. R. McHenry

Cornell Aeronautical Lab., Inc.

Published in HS-011 272, *Handling of Vehicles under Emergency Conditions*, 1969 p61-81

11refs

Report no. Paper-3

Presented at a symposium sponsored by Institution of Mechanical Engineers in cooperation with the Univ. of Technology, Loughborough, England, 8 Jan 1969.

A mathematical model of an automobile is described, which permits the study of simultaneous cornering and ride motions on irregular terrain. A major departure from previous analytical treatments of vehicles is abandonment of the concept of a vehicle-fixed 'hinge' to approximate the changing virtual axis about which roll takes place. Eleven degrees of freedom and all major non-linearities are included in the equations of motion, which are programmed for time-history solutions on a digital computer. Empirical relationships used to generate tire forces over extreme ranges of operating conditions are presented in detail. To ease the task of interpretation of the extensive output information, a computer-graphics display technique has been developed to produce detailed perspective drawings of the vehicle and terrain at selected intervals of time during a simulated maneuver. Comparisons are presented of analytically predicted vehicle responses and test results. Future applications of the described mathematical model, in research related to highway safety, are briefly discussed.

Search terms: Mathematical models; Computerized simulation; Cornering; Vehicle riding qualities; Degrees of freedom; Tire properties; Vehicle soil interface; Equations of motion; Topographical factors; Ran off road accidents; Skidding; Parameters

HS-011 275 Fld. 5/18; 4/7; 5/22

A NEW LOOSE INVERSE PROCEDURE FOR MATCHING TYRES AND CAR USING A MATHEMATICAL MODEL

by A. Chiesa; L. Rinonapoli

Pirelli S.p.A. (Italy)

Published in HS-011 272, *Handling of Vehicles under Emergency Conditions*, 1969 p93-108

4refs

Report no. Paper-4

Presented at a symposium sponsored by Institution of Mechanical Engineers in cooperation with the Univ. of Technology, Loughborough, England, 8 Jan 1969.

Differences of car-handling behavior between normal and emergency conditions have been investigated by mathematically simulating maneuvers of change of lane, entry into a curve, going out from a curve, and straight running in gusty crosswinds. A new "loose inverse procedure" has been utilized to simulate these maneuvers: the trajectory of each is followed, just as in actual road tests, by a tolerance which depends not only on the characteristics of the tires and the car but also on the behavior of the driver. Calculations have shown that stronger tires (i.e. of greater cornering stiffness) make the emergency maneuvers less dangerous, since they increase the stability and the response of the car. Nevertheless, tires of greater cornering stiffness may increase driver-stress in normal maneuvers, since the same steer errors produce larger trajectory errors. This inconvenience may be eliminated if front roll under-steer of the car is increased when these tires are to be utilized.

Search terms: Mathematical models; Vehicle handling; Cornering; Lane changing; Crosswind; Tire characteristics; Vehicle characteristics; Driver

5/18 Steering Control System (Cont'd.)

HS-011 275 (Cont'd.)

behavior; Driver performance under stress; Vehicle stability; Understeer

HS-011 276 Fld. 5/18; 4/7

VEHICLE BEHAVIOUR IN COMBINED CORNERING AND BRAKING

by A. J. Harris; B. S. Riley

England Road Res. Lab.

Published in HS-011 272, *Handling of Vehicles under Emergency Conditions*, 1969 p19-34

7refs

Report no. Paper-5

Presented at a symposium sponsored by Institution of Mechanical Engineers in cooperation with the Univ. of Technology, Loughborough, England, 8 Jan 1969.

The steady-state motions of a simple two-wheeled vehicle model having non-linear sideways force relationships with respect to tire slip angle are considered. It is shown that any steady-state conditions may be represented and their solutions found by simple graphical means using only the non-linear curves. These can be modified to account for the influence of various vehicle parameters. A more involved four-wheeled vehicle model is then considered when subjected to braking while cornering. Actual sideways force-slip angle curves for combined braking and cornering are used with the equations of motion derived for the quasi-steady state conditions of decelerating while cornering. The effects of front wheel steered angle and body slip angle on the forces necessary for the maneuver are also considered. An envelope of maximum cornering acceleration at various braking decelerations is presented. It is also shown that

the total sideways force-slip angle curve for a pair of front or rear wheels, when one or both wheels have a high braking force coefficient, can have a sharp peak, such that for small increase in slip angle there is a rapid fall in sideways force.

Search terms: Tire slip motion; Vehicle handling; Cornering; Braking; Equations of motion; Mathematical models; Parameters; Nonlinear systems; Vehicle stability; Lateral force; Steady state; Slip; Skidding; Vehicle road interface

5/22 Wheel Systems

HS-011 277 Fld. 5/22; 5/18

TYRE FORCES AS FUNCTIONS OF CORNERING AND BRAKING SLIP ON WET ROAD SURFACES

by K. E. Holmes; R. D. Stone

England Road Res. Lab.

Published in HS-011 272, *Handling of Vehicles under Emergency Conditions*, 1969 p35-55

10refs

Report no. Paper-6

Presented at a symposium sponsored by Institution of Mechanical Engineers in cooperation with the Univ. of Technology, Loughborough, England, 8 Jan 1969.

The pure braking and cornering forces of a given tire on a given wet surface at a given speed are functions of braking slip and slip angle respectively. These functional relationships are of great importance in connection with the handling and stability of vehicles and the behavior of brakes and antilocking devices. When cornering and braking occur simultaneously the forces interact and the functional relationships are modified, with consequent effects on vehicle characteristics. The empirical data available on these relationships, both for pure forces and for forces in

combination, are presented. The known effects of such factors as speed, road surface texture, tread pattern, tread resilience, and tire construction are reported. The test vehicle, test procedure and the methods of measuring and evaluating the data are briefly described. Some data have been analyzed statistically to discover the dependence of the various frictional coefficients on factors such as those mentioned above. It is believed that greater use should be made of these statistical techniques in future work. Raw data can also be converted into such practical quantities as braking distances and wheel locking times, by computing theoretically the behavior of model braking systems. An example of such a study is given.

Search terms: Tire forces; Cornering; Braking; Wet road conditions; Tire slip motion; Test equipment; Braking forces; Regression analysis; Tire pavement interface; Vehicle stability; Torque; Tire characteristics; Lateral force; Sideslip; Wheel locking; Models

HS-011 278 Fld. 5/22

NEW TIRE STUD DEVELOPMENTS

by Rolf J. Cantz

Kennametal, Inc.

1972 45p 53refs

Report no. SAE-720116

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

Although studded tires improve vehicle control on icy roads, they contribute to pavement wear. Tests of recently developed tire stud designs show promise that the safety and convenience factors of studded tires can be retained with considerable reduction in road wear caused by their use. Most new tire studs are designed so that the carbide pin will move further into the stud body if the

protrusion of the stud from the tire exceeds a critical limit. The greater the protrusion, the greater the impact force, which causes the road wear. New tire studs having built-in protrusion adjustment capability maintain nearly uniform protrusion throughout their lifetime without being affected by wear resistance of rubber compounds, driving speeds, or road surfaces. Tires with these studs show an increase of 75% in coefficient of friction on smooth ice as compared to identical tires without studs.

Search terms: Tire stud design; Studded tires; Tire studs; Pavement damage; Icy road conditions; Tire traction; Tire skid resistance; Pavement wear; Coefficient of friction; Tire characteristics; Tire wear; Tire performance; Carbides

AVAILABILITY: SAE

HS-011 279 Fld. 5/22

MATERIAL PROPERTIES AFFECTING TRACTION AND WEAR OF PASSENGER TIRES

by R. N. Kienle; K. A. Grosch; C. E. Scott

Uniroyal, Inc.; Uniroyal (Germany); Cities Service Oil.

1972 10p 18refs
Report no. SAE-720161

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

The response of material to interfacial friction and abrasive slippage is discussed. Friction is divided into two factors: viscoelastic and adhesive. With slippage, the adhesive factor results ultimately in abrasion. Abrasion has been studied in the laboratory from a mechanistic approach and in the field from a base material approach. At least two mechanisms have been found: a tensile failure and a fatigue oxidative

failure. Three major components of the tread (carbon black, oil, and polymer) have been found to have the largest influence on friction and wear. Some properties of carbon black and polymers that have been related to wear are reviewed.

Search terms: Tire wear; Tire traction; Tire slip motion; Tire failures; Tire treads; Tire properties; Tire materials; Abrasion; Friction; Polymers; Carbon black; Viscoelasticity; Tensile strength; Oxidation; Wet road conditions; Dry road conditions; Mathematical models; Laboratory tests; Tire tests

AVAILABILITY: SAE

HS-011 280 Fld. 5/22; 2/4

TOWARD THE UNIFIED DESIGN OF TIRE AND PAVEMENT FOR THE REDUCTION OF SKIDDING ACCIDENTS

by A. R. Williams; T. Holmes; G. Lees

Dunlop Co. Ltd. (England); Birmingham Univ. (England)

1972 16p 33refs
Report no. SAE-720162

Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

Pavement characteristics are dominant in the prevention of wet skidding accidents. The tire modifies the pavement properties together with the climatic conditions. Laboratory methods and site investigations have led to an understanding of the relative importance of pavement macro- and microtexture and to the isolation of the factors influencing wet road-hold of vehicles. Improvements in pavement characteristics are urgently required if wet skidding accidents are to be reduced; these changes will also influence future tire design.

Search terms: Tire pavement interface; Pavement skidding characteristics; Wet

skidding; Accident prevention; Wet road conditions; Laboratory tests; Pavement skid resistance; Tire skid resistance; Tire traction; Pavement surface texture; Skidding accidents; Tire design

AVAILABILITY: SAE

NHTSA DOCUMENTS

NHTSA Contractors Reports

HS-800 626 Fld. 5/4; 5/20; 4/7

UNDERRIDE/OVERRIDE OF AUTOMOBILE FRONT STRUCTURES IN INTERVEHICULAR COLLISIONS. VOL. 1. HEAVY VEHICLE REAR UNDERRIDE. FINAL REPORT.

by Norman J. DeLeys; Melvin O. Ryder

Cornell Aeronautical Lab., Inc.

1971 191p 25refs
Contract FH-11-7317
Report no. CAL-VJ-2844-V-3

Analytical and experimental results obtained in a study of requirements and performance of rear underride guards for heavy vehicles are presented. Six tests using a rigid simulated underride guard mounted on an SAE barrier are described. Six full-scale tests were also performed, using prototype underride guard designs mounted on the rear of semitrailer trucks. The effects of impacting vehicle size and weight, impact velocity, rigid and yielding underride guards, and underride guard ground clearance height are among the parameters investigated. Data on pertinent auto and truck geometric characteristics and on various energy dissipating systems for possible application to truck underride guards are presented and discussed. Results from a computer model of vehicle collisions with an underride guard used to explore the effects of various guard load-deflection properties on vehicle impact response are

**NHTSA Contractors Reports
(Cont'd.)****HS-800 626 (Cont'd.)**

described. Recommendations for under-ride guard requirements and compliance tests are given.

Search terms: Mathematical models; Underride guards; Underride override collisions; Rear end collisions; Truck accidents; Vehicle side; Vehicle weight; Impact forces; Ground clearances; Parameters; Vehicle height; Performance tests; Acceleration; Impact tests; Fragmenting tubes; Stress analysis; Deceleration; Crash response forecasting; Compliance tests; Computerized simulation; Semitrailers; Truck design; Energy absorbing rear structures; Automobile design; Simulation models; Load bearing capacity; Heavy duty vehicles; Barrier collision tests; Deflection; Instrumented vehicles

AVAILABILITY: NTIS**HS-800 644 Fld. 3/5****DRIVER TRAINING SIMULATORS, RANGES AND MODIFIED CARS. A REVIEW AND CRITIQUE OF THE EXPERIMENTAL LITERATURE. INTERIM REPORT**

by H. H. Shettel; S. P. Schumacher; R. D. Gatewood

American Institutes for Res.

1971 86p 129refs
Contract FH-11-7322
Report no. AIR-86400-7/71-IR

The more representative kinds of driving simulators, driving ranges, and vehicle modifications are described at a functional level. Papers relating to theoretical issues relevant to training with simulators and methodological problems associated with the conduct of research

in driver education are discussed. Five classes of studies investigating the transfer of driver training from a simulated to an operational environment are criticized. Findings are summarized and discussed and areas for additional research identified.

Search terms: Driving simulators; Driving task analysis; Driver education; Driver education evaluation; Automobile driving ranges; Dual control automobiles; Instrumented vehicles; Automobile modification; Driver skills; Reviews; Learning rates

AVAILABILITY: NTIS**HS-800 645 Fld. 4/5; 5/4****DEVELOPMENT OF A COMPUTER SIMULATION PROGRAM FOR COLLINEAR CAR/CAR AND CAR/BARRIER COLLISIONS. FINAL REPORT**

by J. T. Herridge; R. K. Mitchell

Battelle Memorial Inst.

1972 354p 18refs
Contract FH-11-7550

A computer simulation program is described in which each car may be represented by a lumped-parameter configuration involving up to four masses and 35 nonlinear springs (energy absorbers). User instructions, special options and features, and results of 14 demonstration runs are presented.

Search terms: Vehicle vehicle collisions; Vehicle barrier collisions; Computerized simulation; Simulation models; Computer programs; Parameters; Vehicle mass; Linear systems; Nonlinear systems; Energy absorption; Impact forces; Crashworthiness; Deflection; Collision models; Rear end collisions; Side impact collisions; Mathematical models; Acceleration tolerances

AVAILABILITY: NTIS**HS-800 646 Fld. 5/4; 4/7****UNDERRIDE/OVERRIDE OF AUTOMOBILE FRONT STRUCTURES IN INTERVEHICULAR COLLISIONS. VOL. 2. CAR-TO-CAR HEAD-ON IMPACTS. FINAL REPORT**

by Norman J. DeLeys; David J. Segal; John S. Patten

Cornell Aeronautical Lab., Inc.

1971 331p 17refs
Contract FH-11-7317
Report no. CAL-VJ-2844-V-3

Findings from studies aimed at reducing the damaging consequences of head-on collisions between automobiles with incompatible forward energy absorbing structures are presented. Vehicle and occupant dynamic responses obtained in tests of automobiles impacting at closing speeds in excess of 85 mph are presented and analyzed. The series of four tests included collisions between standard cars and between standard and compact cars, including one small car with a modified bumper system to increase energy dissipation capacity of the front structure and thereby reduce passenger compartment intrusion. Effects of the waveform of vehicle crush properties on occupant injury potential, as determined from computer simulation of the crash victim, are discussed. Formulation of a computer simulation of impacts between bumpers of opposing vehicles is described, together with results of simulated low-speed bumper under/override collisions.

Search terms: Head on collisions; Underride override collisions; Energy absorbing front structures; Energy absorbing bumpers; Impact forces; Computerized simulation; Simulation models; High speed impact tests; Low speed impact tests; Occupant protection; Vehicle vehicle impact tests; Vehicle size; Restraint system tests; Injury factors; Compact automobiles;

Crashworthy bodies; Crushing; Human body simulation; Automobile modeling; Occupant modeling; Mathematical models; Instrumented vehicles; Acceleration; Anthropometric dummies; Deceleration; Bumper design; Deflection

AVAILABILITY: NTIS

HS-800 648 Fld. 3/7

COLLECTION, ANALYSIS, AND INTERPRETATION OF DATA ON RELATIONSHIP BETWEEN DRUGS AND DRIVING. FINAL REPORT

by B. A. Moser; L. D. Bressler; R. B. Williams

Research Triangle Inst.

1972 183p
Contract DOT-HS-022-1-023

The purpose of this study was to determine if drug usage is related to driving history. Laboratory analyses of urine samples, in-depth interviews, and public driving records were studied to determine relationship of traffic accidents and violations to alcohol and drug use in male users and nonusers. Frequency and amount of drug use were analyzed in terms of driving performance for 1,889 persons arrested for serious crimes. In general, the results show that for this population, drug users have no worse driving records in terms of accidents and convictions than nondrug users.

Search terms: Data acquisition; Data analysis; Drug addiction; Driving; Problem drivers; Traffic law violations; Accident rates; Accident repeater drivers; Urinalysis; Driver interviews; Driver records; Male drivers; Driver criminal history; Driver performance; Arrests; Drug effects; Laboratory tests; Alcohol effects; Drinking drivers; Alcohol usage; Driver characteristics

AVAILABILITY: NTIS

HS-800 653 Fld. 3/12; 5/20; 5/2

FIELD OF VIEW REQUIREMENTS DIRECTLY BEHIND TRUCKS AND BUSES. FINAL REPORT

by Martin L. Reiss; Harold Lunenfeld; George W. Morton

Airborne Instruments Lab.

1972 188p 50refs
Contract DOT-HS-112-I-162
Report no. 5529-9

The blind area directly behind trucks and buses was investigated to determine the information elements the driver needs to reduce risk. Accident data, driver evaluations of risk and information needs, and vehicle use patterns were utilized to determine that the blind area increases driving risk most for backing, turning, slowing, and stopping in that order. A comparison was made of alternative techniques for eliminating the blind area behind vehicles, and it was concluded that an effective rear vision system would have a positive payoff in accident prevention. The most promising techniques appear to be TV systems, closing rate sensors (doppler radar), and proximity sensors (acoustic). Existing periscope systems were not feasible for larger vehicles. Fiber optics, infrared sensors, laser sensors did not meet performance and cost criteria. The primary recommendation is to perform tests and demonstrations on existing systems.

Search terms: Blind spots; Trucks; Buses; Accident risks; Television; Sensors; Periscopes; Fiber optics; Infrared scanning; Lasers; Performance characteristics; Environmental factors; Rearview mirrors; Systems analysis; Accident analysis; Accident costs; Vehicle usage; Interviews; Driver mileage; Accident prevention; Hazard perception; Flow charts; Driving conditions; Rear viewing devices; Rear visibility; Turning; Backing; Speed patterns; Benefit cost analysis; Radar;

Speed sensors; Vehicle size; Field of view; Truck accidents

AVAILABILITY: NTIS

HS-800 654 Fld. 5/4

SIDE IMPACT CRASH-WORTHINESS OF FULL-SIZE HARDTOP AUTOMOBILES. FINAL REPORT, PHASE I

by L. M. Shaw

Dynamic Science

1972 165p
Contract DOT-HS-046-1-209
Report no. 2310-72-6

Side impact crash response characteristics for late model hardtop autos were determined through five side impact crash tests involving both vehicle-vehicle and pole simulations. Results indicate that present hardtop autos provide little crashworthiness to resist side impact occupant compartment intrusion, which was the prime parameter affecting occupant safety, as crash acceleration was generally low. An analytical computer simulation was generated to assist in a design trade-off analysis for determining promising structural modifications to improve side impact crashworthiness. A preliminary design configuration was selected for further analysis and development.

Search terms: Crashworthiness; Crashworthy bodies; Side impact collisions; Vehicle vehicle impact tests; Pole impact tests; Occupant protection; Acceleration; Simulation models; Computerized simulation; Safety design; Automobile design; Impact forces; Automobile models; Passenger compartments; Crush distance; Computer programs; Deformation; Mathematical models

AVAILABILITY: NTIS

**NHTSA Contractors Reports
(Cont'd.)**

HS-800 657 Fld. 3/6

**IOWA IMPROVED DRIVER
LICENSING PROCEDURES
DEMONSTRATION PROJECT.
CLOSED CIRCUIT COLOR TELE-
VISION ELECTRO-MECHANICAL
TEACHING/TESTING LI-
CENSING SYSTEM. FINAL RE-
PORT**

by Alton B. Chrystal

Iowa Dept. of Public Safety

1971 94p 31refs
Contract FH-11-7323

An electromechanical system was developed to test applicants for driver licenses and to score their driving knowledge and ability to respond favorably to driving situations. The system is designed to provide the correct response to each question presented, as well as related teaching information justifying the reasoning for the correct answer. Relevant laws and safety materials are also provided. Each applicant is positioned in an individual console with design providing the proctor both visual and hard copy printouts for the applicant's progress and final test results. The design further provides for continuity to the extent that applicants may begin and complete the examination independently of other applicants.

Search terms: Driver evaluation devices; Driver license examination; Iowa; Driver tests; Closed circuit television; Television in testing; Driver skills; Programmed instruction; Instruction materials; Electronic monitoring systems; Demonstration projects

AVAILABILITY: NTIS

NHTSA Staff Speeches, Papers, etc.

HS-810 198 Fld. 3/5

**TRAFFIC SAFETY EDUCATION
FOR THE 70'S**

by Charles H. Hartman

National Hwy. Traf. Safety Administration

1972 18p

Presented at Massachusetts Driver and Traffic Safety Education Association state conference, Falmouth, 12 May 1972.

Driver and traffic safety education are discussed. Aspects described are: legal authority and mandate to conduct programs in the schools; organization and administration of the programs; teacher selection, preparation, and licensing; driving task analysis; developments in curriculum and instruction; new facilities and equipment; evaluation, research, and development; public information and support.

Search terms: Driver education; Driver education evaluation; High school driving courses; Instructors; Curricula; Instruction materials; Driving task analysis; Community support; Safety education; Child safety education; Legal factors

AVAILABILITY: NHTSA

HS-810 200 Fld. 3/4

**IMPROVED DRIVER PERFORM-
ANCE AND DRIVER/VEHICLE/
ENVIRONMENT INTERACTION**

by Charles H. Hartman

National Hwy. Traf. Safety Administration

1972 15p

Presented at International Vehicle and Highway Safety Conference, Washington, D.C., 31 May 1972.

The purpose of this paper is to describe the interactive process that goes on continually among the driver, the vehicle, and the environment in a traffic situation. Driver performance can be improved by teaching people the skills and knowledge necessary for safe driving and by attacking factors which impair driving. The most important impairment factor is alcohol. Various alcohol countermeasures are described, including better detection equipment for police use and alcohol interlock systems. Also discussed are driver training for emergencies, safer vehicle design, the driver's visual task, and better highway signs.

Search terms: Driver vehicle interface; Environmental factors; Driver performance; Driver skills; Driver education; Drinking drivers; Alcohol effects; Alcohol usage deterrents; Alcohol chemical tests; Alcohol detection and interlock systems; Driver emergency responses; Automobile design; Safety design; Driving tasks; Driver vision standards; Highway signs

AVAILABILITY: NHTSA

NHTSA Imprints

HS-820 185 Fld. 1/3

**SOCIETAL COSTS OF MOTOR
VEHICLE ACCIDENTS.
PRELIMINARY REPORT**

National Hwy. Traf. Safety Administration

1972 56p 25refs

This analysis of accident costs is based on the concept that calculable losses are experienced by society regardless of whether all components have been translated into economic costs. Loss

JULY 21, 1972

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categories evaluated include property damage, medical costs, productivity losses, insurance administration, losses to other individuals, employer losses, funeral costs, community service losses, pain and suffering, and miscellaneous costs. The annual total cost of highway accidents is estimated at \$45 billion. The

loss from each fatality is estimated at \$200,000, each nonfatal injury at \$7,300, and each property damage accident at \$300.

Search terms: Accident costs; Injury costs; Damage costs; Medical costs; Insurance costs; Legal costs; Life

value; Life years lost in accidents; Accident severity; Injury severity; Fatalities; Sociological factors; Life expectancy; Accident compensation; Disability evaluation; Income; Pain; Accident factors

AVAILABILITY: NHTSA

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